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Investigations on the Caesium Iodide Transport in a Thermal Gradient Tube

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Abstract

During a severe accident of a light water reactor (LWR), fission products may be transported through reactor primary circuit before ending up to the containment atmosphere. The transport and chemistry of the fission products released from the fuel to the containment atmosphere are key phenomena, which need to be understood in the context of severe accident management. Due to the radiological consequences that may result from their release into the environment, iodine and caesium chemistry have been the subject of numerous studies. For decades, several researches have been led to understand the behaviour of the caesium iodide in the primary circuit in the objective of assessing the fraction of gaseous iodine, which could reach the containment atmosphere. Important reactions have been identified and studied in detail, so that their effects could be incorporated in accident analyses. After the Fukushima accident, significant amounts of ^{137}Cs and ^{131}I were dispersed into the environment, verifying the importance to further reinforce the understanding and predictability of iodine species exiting the primary circuit.

The main focus of this work was to study the transport of caesium iodide particles through a Thermal Gradient Tube (TGT), in which temperature decreased from 750 °C to 150 °C under Ar/H_2O atmosphere (80/20 vol.%). The influence of the flow rate on CsI transport was investigated. The second objective of this study was to evaluate the possible revaporisation or/and resuspension processes by flowing a carrier gas composed of either Ar/H_2O, Ar/Air or Ar/H_2 above the deposited/condensed caesium iodide on TGT surfaces.

The released particles and gaseous species were collected on filters and trapped in liquid scrubbers respectively and analyzed with ICP-MS. The properties of particles transported through the TGT, such as mass concentration and particle number size distribution, were monitored with online measurement devices (TEOM, ELPI and SMPS). The concentration of water vapor was online monitored with FTIR.
A preliminary analysis of the tests was performed with SOPHAEROS, module of ASTEC (Accident Source Term Evaluation Code) code.

First experimental results showed a very small amount of caesium iodide was deposited/condensed inside the TGT, when the flow rate was 4 l/min. In addition, the atmosphere composition of Ar/H_2 seemed to have the most influence in the revaporisation/resuspension of the deposited/condensed material.

Keywords: Caesium iodide, LWR, Severe accident